APPENDIX F

DRAFT MONITORING PLAN

JACKSONVILLE HARBOR NAVIGATION (DEEPENING) STUDY

DUVAL COUNTY, FLORIDA

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1 MONITORING PLAN SUMMARY

The U.S. Army Corps of Engineers (USACE) proposes to improve navigation within Jacksonville Harbor by deepening approximately 13 miles of the Federal channel, which is located within the lower St. Johns River (LSJR). Hydrodynamic modeling predicts that the deepening would increase the river's salinity level from approximately the Dames Point Bridge (River Mile [RM] 11) to at least the Shands Bridge (RM 50). Ecological modeling, utilizing the hydrodynamic output, indicates that this salinity increase would result in slightly elevated stress levels on wetlands, eelgrass (*Vallisneria americana*) beds, and may affect distribution and recruitment of fish and macroinvertebrates. In coordination with government agencies, the USACE has developed a long-term (15 years) monitoring plan in order to determine whether the models have accurately predicted the effects. Monitoring data will also be used to evaluate whether the proposed mitigation sufficiently offsets the predicted impacts. Components of the plan would include installing a new system of water quality monitoring stations on the main stem of the St. Johns River as well as selected tributaries. All of the stations would continuously monitor salinity and dissolved oxygen. Tidal water level and flow gauges would also be installed on tributaries. Selected eelgrass beds, wetlands, as well as fish abundance and composition would be monitored. Monitoring would provide data on observable changes within these ecosystem components; however, additional hydrodynamic modeling would also be annually performed to determine potential causes of change such as lack of rainfall, sea level rise or deepening the channel. In the event that hydrodynamic modeling indicates that salinity levels induced by deepening are greater than what was predicted, then the ecological models (SAV, wetlands, and fish) would also be run in order to better understand the extent of impact. The results of these analyses will be provided to the agencies and stakeholders. The total estimated cost for the implementation of the monitoring plan is $11,338,000.

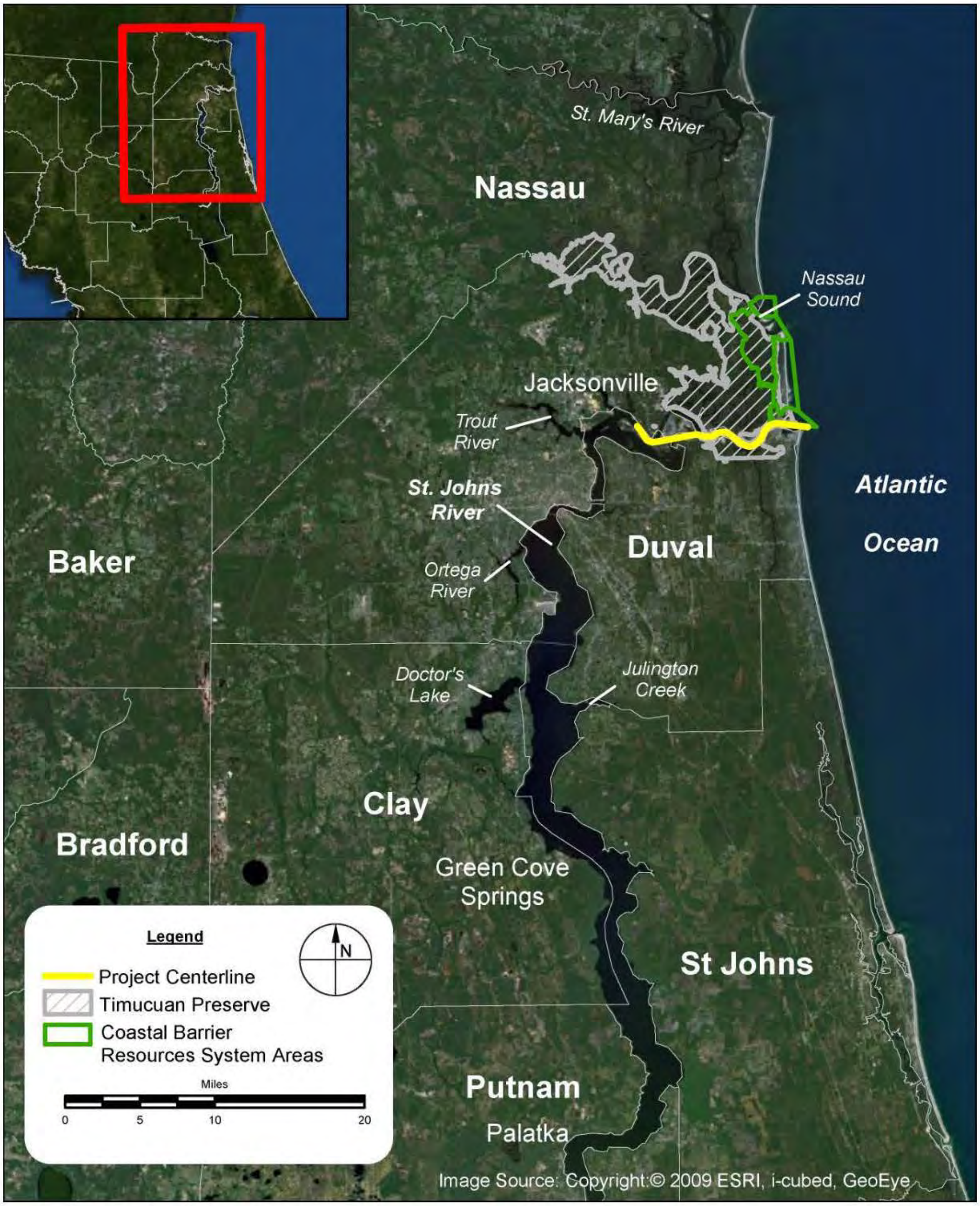
2 PROJECT DESCRIPTION

Jacksonville Harbor is located within the St. Johns River, Duval County, Florida. The harbor project provides access to deep draft vessel traffic using terminal facilities located in the City of Jacksonville (refer to **Figure 1)**.

Figure 1. Location of Jacksonville Harbor

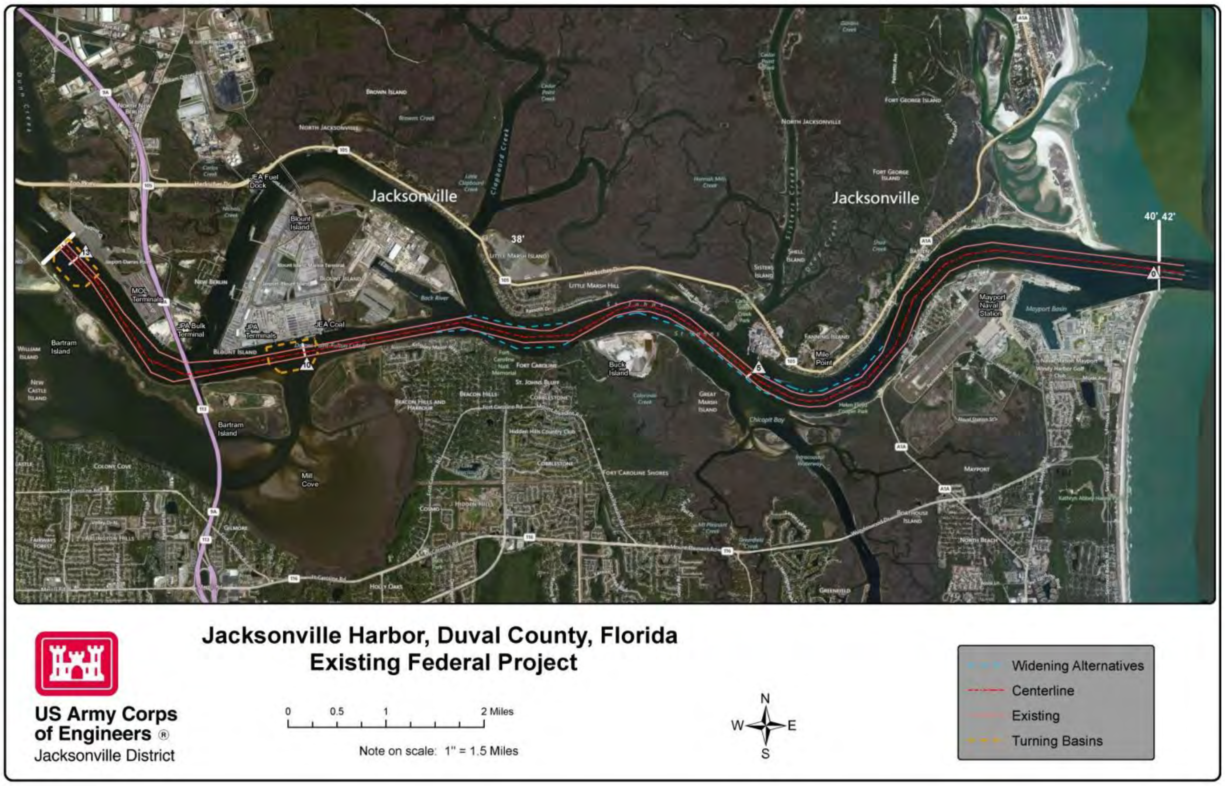
The environmental study area includes the Jacksonville Harbor entrance channel and the Lower St. Johns River (LSJR). For this study, the LSJR begins at the confluence of the river and the Atlantic Ocean, and extends some 101 river miles upstream to a point slightly downstream of Lake George as shown in **Figure 2**.

Figure 2. Environmental Study Area



The purpose of this General Re-evaluation Study is to develop and evaluate alternate plans to address navigation concerns within Jacksonville Harbor. Alternatives being evaluated include deepening the channel from its currently authorized depth of 40 feet to 44 feet, 45 feet (National Economic Development Plan), 46 feet, 47 feet (Locally Preferred Plan), and 50 feet. The USACE proposes to provide 2 additional feet of advance maintenance dredging to each of these depths. Two widening areas and two turning basins are also being evaluated (refer to **Figure 3**).

Figure 3. Project Map



3 SALINITY IMPACTS

3.1 HYDRODYNAMIC MODELING

The EFDC hydrodynamic and salinity model, validated for the Jacksonville Harbor Deepening Study, provided the means to assess the direct impacts of channel modifications to salinity and water circulation in the main stem of the LSJR. This study applied the model to simulate and analyze the project impact during a six-year evaluation period. The six-year evaluation period includes the lowest river flow during any three-year period in the river's 78-year flow record. Thus, this study's evaluation presents conservative estimates of the impacts of the Jacksonville Harbor Deepening Project. Notably, the evaluations assumed completion of the Mile Point and Mayport deepening projects with the Jacksonville Harbor Deepening. Please note that additional modeling will be performed.

Model results associated with conditions immediately after construction of the Jacksonville Harbor Deepening Project show that:

1. Project at 44 ft will likely increase tide range by 0.2 ft at Long Branch and Main Street Bridge. The salinity will likely increase by 0.3 – 0.4 ppt from Dames Point to Buckman Bridge with smaller increases upstream of Shands Bridge. The project will likely not reduce water circulation in the study area.

2. Project at 46 ft will likely increase tide range by 0.4 ft at Long Branch and Main Street Bridge. The salinity will likely increase by 0.5 – 0.7 ppt from Dames Point to Buckman Bridge with smaller increases upstream of Shands Bridge. The project will likely not reduce water circulation in the study area.

3. Project at 50 ft will likely increase tide range by 0.2 ft at Bar Pilot, by 0.4 ft at Long Branch, and by 0.1 ft at Main Street Bridge. The salinity will likely increase by 0.3 – 0.8 ppt from Dames Point to Buckman Bridge with smaller increases upstream of Shands Bridge. The project can slightly impede downstream river flow and slightly increase water age as the project allows more ocean water to flow upstream. However, the change in water age is small enough (e.g., water age stays 7 days longer at select water age values per year) that the project will likely not significantly reduce water circulation in the study area.

Model results associated with conditions with 0.39 ft sea level rise (historical rate) and 155 million gallons per day (MGD) upstream river water withdrawal at 50 years after construction of the Jacksonville Harbor Deepening Project show that:

1. Project at 44 ft will likely increase future tide range by 0.1 ft at Long Branch and Main Street Bridge. Future salinity will likely increase by 0.5 – 0.8 ppt from Dames Point to Buckman Bridge with smaller increases upstream of Shands Bridge. The project will likely not reduce future water circulation in the study area.

2. Project at 46 ft will likely increase future tide range by 0.2 ft at Long Branch and Main Street Bridge. Future salinity will likely increase by 0.6 – 1.0 ppt from Dames Point to Buckman Bridge with smaller increases upstream of Shands Bridge. The project will likely not reduce future water circulation in the study area.

3. Project at 50 ft will likely increase future tide range by 0.1 ft at Bar Pilot, by 0.2 ft at Long Branch, and by 0.1 ft at Main Street Bridge. The salinity will likely increase by 0.7 – 1.5 ppt from Dames Point to Buckman Bridge with smaller increases upstream of Shands Bridge. The project will likely not reduce water circulation in the study area.

In general, the sea level rise and upstream river water withdrawal will likely reduce the project water level impacts by approximately 50%. However, the water age associated with sea level rise and upstream river water withdrawal is about twice more than post-project construction for water ages greater than 150 days. Finally, this study applied a set of hydraulic and meteorological conditions that are weighted toward low flow dry years for the salinity and circulation modeling. This means the project impacts presented here are likely greater than the project may cause during an average hydrological and meteorological year.

Please refer to Appendix TBD to review the hydrodynamic modeling report.

3.2 ECOLOGICAL MODELING

SUBMERGED AQUATIC VEGETATION (SAV) MODEL: The SAV species used in this modeling effort is most commonly referred to as eelgrass (*Vallisneria americana*). The results of the baseline simulation indicate temporally and spatially variable salinity stress on eelgrass beds from the Fuller Warren Bridge to approximately NAS Jacksonville. Long (up to several months), widespread periods of salinity stress occur during the driest modeled years. These results appear consistent with field observations of declines in eelgrass beds during recent dry years. Increasing the channel depth causes progressively greater salinity stress superimposed on the already variable patterns of the baseline condition. Deepening induced salinity stress is predicted to occur from the Fuller Warren Bridge (RM 25) upstream to a point (RM 36) between the Buckman Bridge and Doctors Inlet. When deepening is combined with the historical rate of sea level rise, this effect continues upstream to Doctors inlet (RM 37). Generally, the differences due to the project alternatives are much less than the annual differences due to variable hydrologic conditions. Nonetheless, the additional stress imposed by any of the proposed project alternatives will likely contribute to upstream migration of the northern limit of eelgrass in the LSJR (refer to **Table 1**).

Table 1. Stress in Acres/Days for Eelgrass Beds

Stress Condition	Acres/day							
	Current Condition				50-yr Condition			
	Base 40 ft	44 ft	46 ft	50 ft	Base 40 ft	44 ft	46 ft	50 ft
No Effect	10,983	10,845	10,826	10,764	10,627	10,303	10,282	10,212
Low	2,721	2,739	2,738	2,754	3,014	3,077	3,074	3,088
Moderate	1,378	1,407	1,410	1,402	1,553	1,591	1,597	1,606
Extreme	298	389	401	446	380	582	604	664

WETLANDS MODEL: Sensitive wetlands would be affected by salinity stress induced by the proposed deepening; however, additional on-going analyses need to be completed in order to determine the extent of the effects. The USACE wetland team has developed wetland salinity breakpoints based on the frequency of occurrence of specific salinities at high tide. Such a relationship between high tide salinity and wetland community characteristics has been observed in other east coast river/marsh systems. In addition, supplemental hydrodynamic modeling simulations of salinity in tributaries outside of the current EFDC model domain will be initiated to provide insight about potential impacts to wetlands that do not lie along the main stem of the river. Preliminary analysis indicates that wetlands within the project zone of impact are already being affected by increasing salinity levels. Changes in vegetation are occurring. Increasing salinity levels in the river will also increase sulfate levels within the soil. Increasing sulfate levels can stimulate accelerated mineralization of organic carbon, which can result in the loss of the organic matrix or a collapse of soil surface. The deepening is expected to slightly increase the rate of these ongoing effects, and the project zone of impact is predicted to occur on the main stem of the river primarily from the Fuller Warren Bridge (RM 25) to a point upstream of Black Creek (RM 47). Sensitive wetlands along tributaries downstream of RM 47, and below head of tide, would also be within this potential zone of impact.

FISH MODEL: Fish may also be affected by salinity stress induced by the proposed deepening; however, additional on-going analysis of the Fisheries Independent Monitoring (FIM) dataset and tributary modeling needs to be completed in order to make this determination. Salinity modeling in the tributaries and adjacent wetlands is being initiated to provide needed data on potential salinity changes that could affect the availability of fixed habitat (the appropriate salinity in the wetlands at the appropriate season). Examination of salinity patterns in the main stem could help assess the potential effect of salinity regime changes on salinity related behaviors in fish species/pseudospecies. There are a number of species that show very discrete cohort growth patterns at least for recruitment and initial growth stages. This pattern allows direct examination of salinity and life history events in samples collected as part of the FIM dataset. Other species show clear periods of presence absence, which may also serve as effective example species to consider salinity effects. Such analyses combined with salinity modeling of the tributary and adjacent wetlands may provide clarification on the potential effects of the proposed deepening.

Please refer to Appendix TBD to review the report on ecological modeling.

4 GOAL OF MONITORING

According to the Council on Environmental Quality, and pursuant to the National Environmental Policy Act, Federal agencies have a continuing duty to gather and evaluate new information relevant to the environmental impact of its actions (see U.S.C. § 4332 [2][A]). Furthermore, 40 CFR § 1503.3 states that agencies may provide for monitoring to assure that their decisions are carried out and should do so in important cases.

In coordination with its agency partners, the USACE has developed a long-term monitoring plan in order to determine whether the models have accurately predicted salinity induced effects. Monitoring data will also be used to evaluate whether the proposed mitigation sufficiently offsets the predicted impacts. The monitoring program would be initiated prior to, or concurrent with, the first year of construction. The duration of the construction is estimated at 5 years. Monitoring would occur throughout this 5 year period, and for 10 years post construction (15 years total). The USACE and the agencies agree that this period of time is necessary to evaluate the effects of the proposed work.

5 WATER QUALITY (SALINITY) MONITORING

The U.S. Geological Survey currently operates water quality monitoring stations, including salinity sensors, at Dames Point, Buckman Bridge, and Dancy Point. As part of the Physical Oceanographic Real-Time System (PORTS) Awareness Project, the Jacksonville Marine Transportation Exchange in partnership with the National Oceanic and Atmospheric Administration propose to add stations, including salinity sensors, at Mayport, Jacksonville University, and Shands Bridge. Information from these stations could be used by USACE to monitor future LSJR salinity levels. However, if they are not operating at the time of the proposed deepening, then a new system of monitoring stations would be installed, or updated, at the following locations: Dames Point Bridge (≈ RM 11), Acosta Bridge (≈ 24-25), Buckman Bridge (≈ RM 34-35), Shands Bridge (≈ RM 50), and Federal Point (≈ RM 68). Stations would also be installed within the following LSJR tributaries (in order of priority): Six Mile Creek, Clapboard Creek, Ortega River, Black Creek, Julington Creek, Doctors Inlet, Arlington River, Trout River, and Broward River (refer to **Figures 4 and 5)**. These main stem and tributary sites were selected because they bracket the predicted salinity impacts induced by the deepening project. Also, they have had monitoring stations at various times with the exception of Doctors Inlet; therefore, historical data would be available for comparison purposes. Doctors Inlet was selected at the request of the agencies because of its biological importance. All of the stations would continuously monitor surface and bottom salinity and dissolved oxygen. Tidal water level and flow gauges would also be installed within tributaries. Data would be electronically sent to a central location where it would be placed on a website for public viewing. Offshore monthly water quality monitoring including, but not necessarily limited to, salinity, dissolved oxygen, and plankton is also recommended. Total cost over the 15 year monitoring period is estimated at $4,180,000 (refer to **Table 2**).

Table 2. Water Quality Monitoring Cost Breakdown

Item	Per Unit	Total Units	Total Cost
Station Installation (River)	$35,000	$175,000 (5 units)	$175,000
Station Installation (Tributary)	$45,000	$405,000 (9 units)	$405,000
Operation	$15,000/year	$210,000/year (14 units)	$3,150,000/15 years
Offshore Monitoring	$30,000/year		$450,000/15 years
TOTAL COST			**$4,180,000**

Figure 4. Water Quality Monitoring Stations (Northern Study Area)

Figure 5. Water Quality Monitoring Stations (Southern Study Area)

6 EELGRASS MONITORING

Eelgrass (*Vallisneria americana*) beds would be monitored at the following locations: Bolles High School, Buckman Bridge, Moccasin Slough, and Scratch Ankle (refer to **Figure 6**). These sites were selected because they bracket the predicted salinity impact zone for this species. Scratch Ankle would serve as an upstream control site. These same sites were also monitored by the St. Johns River Water Management District up until 2009; therefore, historical data would be available for comparison purposes. Quarterly sampling would be performed in order to detect subtle changes potentially caused by water quality and seasonal effects. Two transects would be selected at each site and data collected on species composition, canopy height, and percent cover. Total cost over the 15 year monitoring period is estimated at $648,000.

Figure 6. Eelgrass Monitoring Stations

7 WETLANDS MONITORING

A wetland would be selected and monitored in each of the following tributaries: Ortega River, Julington Creek, Black Creek, and Six Mile Creek (refer to **Figure 7**). These tributaries were selected because they bracket the predicted salinity impact zone for wetlands. Also, as stated in Section 5, each of these tributaries would have a flow gauge upstream of the monitored wetland, which would allow local rainfall events to be incorporated into the analyses. Six Mile Creek would serve as an upstream control site. Bi-annual sampling would be conducted, and would occur during the beginning portion of the growing season (April-May) and again towards the end of the growing season (September-October). Sampling twice a year is expected to yield more complete data on species composition. Soil samples would be taken from each wetland during each survey, and analyzed for salinity level using the Saturated Paste Method. Field measurements using a soil conductivity probe would also be collected. Freshwater wetland soils are dominated by methanogenic bacteria; therefore, biogeochemical monitoring to determine whether soils are Methanogenic or sulfate reducing, i.e. exposed to salt water, would be performed. Stations (nested plots) would be established at each wetland, and all plants within the stations would be identified and tabulated during each bi-annual survey. A visual estimate of cover using a cover scale would be performed. Total cost over the 15 year monitoring period is estimated at $825,000.

Figure 7. Wetlands Monitoring Stations

8 FISH AND MACROINVERTEBRATE (NEKTON) MONITORING

The principal objective of this monitoring is to develop nekton abundance and species composition data within LSJR tributaries that will be used to assess potential changes from channel deepening. This will be accomplished by incorporating selected tidal tributaries, located between the river mouth (RM 0) and Julington Creek (RM 39) of the LSJR, as specific strata in the FIM program sampling design. The select tributaries to be included as strata are, from South to North: Julington Creek, Ortega River, Arlington River, Trout River, and Clapboard/Sisters creeks.

Monthly nekton collections will follow established FIM sampling protocols for a 15 year period in select tidal tributaries. It is imperative to establish baseline community metrics for the selected tributaries prior to channel deepening operations. Sampling through the dredging operations will allow for assessment of any direct impacts of the dredging operations itself. An extended period of sampling post dredging will be important for assessing recovery from any direct impacts from the dredging and allow for the nekton assemblages to stabilize before assessing final impacts that are directly related to the actual deepening. The proposed sampling will occur in five tidal tributary systems in the LSJR. Sampling effort will consist of 50 samples each month with the sampling effort being proportionally distributed between each of the five tributary systems and two gear types based upon available habitat (refer to **Table 3**).

The FIM program collects nekton samples with three sampling gears in the LSJR: 1) 21.3-m seines which target small bodied nekton in shallow waters (≤1.6-m) that are associated with shorelines; 2) 6.1-m otter trawls which target small and large bodied nekton in waters from 1.8 to 7.6-m; and 3) 183-m seines which target larger bodied juvenile and adult fishes in waters associated with shorelines. The nekton life history stages that are collected with 21.3-m seines and 6.1-m trawls are the most likely to be impacted directly by dredging operations and channel deepening and, therefore, are the two gears proposed for inclusion in this study.

Table 3. Nekton Sampling Design

Tributary (Zone)	Current # FIM Grids	Number of Strata (subzones)	# 21.3-m seines/month	# 6.1-m trawls/month	Total Nets/Month
Julington Creek	8	2	4	4	8
Ortega River	8	2	4	4	8
Arlington River	6	1	3	3	6
Trout River	12	2	6	6	12
Clapboard/Sisters creeks	16	4	8	8	16
Totals			**25**	**25**	**50**

Water quality profiles will be taken in association with each gear deployment. Temperature, conductivity, pH and dissolved oxygen will be measured electronically at surface and bottom and at one-meter intervals between surface and bottom.

The table below shows the yearly cost of the project by year for the 15-year proposed sampling period. Initial cost per sample will be $300. There is a 5% cumulative increase in the cost per sample after sample years 5 and10 that will be used to offset anticipated increases in labor and fuel costs.

Table 4. Nekton Monitoring Costs

Sample Year	Cost Per Net	Nets Per Year	Cost
Year 1	$300	600	$180,000
Year 2	$300	600	$180,000
Year 3	$300	600	$180,000
Year 4	$300	600	$180,000
Year 5	$300	600	$180,000
Year 6	$315	600	$189,000
Year 7	$315	600	$189,000
Year 8	$315	600	$189,000
Year 9	$315	600	$189,000
Year 10	$315	600	$189,000
Year 11	$330	600	$198,000
Year 12	$330	600	$198,000
Year 13	$330	600	$198,000
Year 14	$330	600	$198,000
Year 15	$330	600	$198,000
Total Project Cost		**9,000**	**$2,835,000**

9 FUTURE MODELING

Monitoring can provide data on changes in salinity levels as well as observable changes within wetlands, eelgrass beds, and fish communities; however, monitoring alone cannot determine the cause of potential change in any of these ecosystem components, and this is especially true in a large and complex estuary such as the LSJR Basin. For example, several factors can influence the basin's salinity levels including sea level rise, lack of freshwater inflow or lack of rainfall, as well as the proposed deepening. Therefore, additional hydrodynamic modeling will be annually performed for the 15 year monitoring period in order to determine the factors contributing to any potential changes induced by increasing levels of salinity. Data obtained from the network of main stem and tributary water quality monitoring stations would be utilized by the model. In the event that hydrodynamic modeling indicates that salinity levels induced by deepening are greater than what was predicted, then the ecological models (SAV, wetlands, and fish) would also be run in order to better understand the extent of impact. Please refer to Appendix TBD for more information on predicted salinity levels induced by the deepening. Total cost over the 15 year monitoring period is estimated at $3,300,000.

10 INFORMATION DISSEMINATION

Water quality monitoring information would be placed on a website for public viewing. Eelgrass, wetlands, fish monitoring as well as modeling reports would also be posted on a public website. Information on accessing the data and reports would be made available to stakeholders prior to posting.

11 COST SUMMARY

Table 5. Total Estimated Costs of Monitoring

MONITORING PLAN COMPONENT	COST
WATER QUALITY	$3,730,000
EELGRASS	$648,000
WETLANDS	$825,000
NEKTON	$2,835,000
MODELING	$3,300,000
TOTAL	**$11,338,000**